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DESIGNING AND DELIVERING A SUSTAINABLE FUTURE

ENVIRONMENTAL IMPACT ASSESSMENT REPORT (EIAR) FOR THE PROPOSED DREHID WIND FARM AND SUBSTATION, CO. KILDARE

VOLUME 2 – MAIN EIAR

CHAPTER 7 – NOISE AND VIBRATION

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Date: May 2025

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7. NOISE AND VIBRATION

7.1 Introduction

This chapter contains an assessment of the potential noise and vibration impacts associated with the Proposed Development. The assessment including undertaking of background noise surveys has been carried out by Fehily Timoney & Company, based on information provided by Statkraft Ltd and in accordance with current guidance and best practice. Descriptions of the Proposed Development are provided in Chapter 3 – Description of the Proposed Development of Volume 2 of the EIAR.

Potential construction noise and vibration impacts have been determined with reference to *British Standard 5228:2009+A1:2014 Code of Practice for Noise and Vibration Control on Construction and Open Sites Part 1 Noise*. Construction noise associated with the Proposed Substation construction and grid connection works, are assessed in section 7.5.1.

Potential operational noise impacts associated with the Proposed Wind Farm have been determined with reference to the UK Institute of Acoustics', *A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise* (2013) and compared with noise limits derived from the Department of the Environment, Heritage and Local Government's *Wind Energy Planning Guidelines* (2006).

The noise limits provided in the latter document are being updated, but these revisions have not yet been adopted and released. They were anticipated to be updated in 2024, but to date, these have not been published. As such, the current noise limits from the 2006 guidelines are used in this assessment, although it should be noted that it is possible to comply with revised noise limits through appropriate curtailment or shut down of particular turbines during daytime or night-time periods, as appropriate.

Operational noise associated with the introduction of the Proposed Substation has been assessed with reference to BS 4142:2014+A1:2019, *Methods for rating and assessing industrial and commercial sound*, assessed in section 7.5.2.2

Decommissioning noise and vibration impacts have been discussed with similar references to the construction noise discussion.

7.2 Potential Noise and Vibration Impacts

7.2.1 Construction Noise and Vibration

Noise is generated from the construction of the turbine foundations, the erection of the turbines, the excavation of trenches for cables, and the construction of associated hard standings, access tracks, construction of compound and substation and construction of berms.

Noise from vehicles on local roads and access tracks is also generated from the delivery of the turbine components and construction materials, notably aggregates, concrete and steel reinforcement.

Vibration is generated by construction activities such as rock breaking and passing heavy goods vehicles. The threshold of human perception of vibration is in the range of 0.14mm/s to 0.3mm/s[1] , described as *"might just*

[1] British Standard 5228 Part 2:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites- Part 2: Vibration

be perceptible". The guideline values for damage to buildings from vibration are 15mm/s at 4Hz increasing to 20mm/s at 15Hz and 50mm/s at 40Hz and above.

Typical vibration generated from construction activities for The Proposed Development project are:

- •Tracked excavators and disc cutters from cable trenching (0.8mm/s at 4m)
- •Pneumatic breakers for cable trenching (1.8mm/s at 4m)
- •HGV traffic on normal road surfaces (0.01 to 0.2 mm/s) at footings of buildings located a maximum of 20m from roadway

As described in Chapter 3 Description of the Proposed Development, there is a proposed on-site connection between the on-site substation and a loop-in/loop out infrastructure connection to the 110kV Kinnegad-Rinwade overhead line. The closest dwelling (nearest non involved landowner) is approximately 145 m from the proposed grid connection works. The nearest dwelling (nearest non involved landowner) to other construction activities is approximately 48 m away. In addition there is a family member of an involved landowner (R134) at 25m east of the main southern site access road. Based on these separation distances, vibration will not be perceivable by human receivers at their properties and building damage will not occur from construction incurred vibration e.g. earthworks and truck movements on haul roads. As such, construction vibration will not be considered further in this appraisal.

7.2.2 Operational Noise and Vibration

Noise is generated by wind turbines as they rotate to generate power. This only occurs above the 'cut-in' wind speed and below the 'cut-out' wind speed. Below the cut-in wind speed there is insufficient strength in the wind to generate efficiently and above the cut-out wind speed the turbine is automatically shut down to prevent any malfunctions from occurring. The cut-in speed at turbine hub-height is typically about 3 metres per second (m/s) and the cut-out wind speed is about 25 m/s.

The principal sources of noise are from the blades rotating in the air (aerodynamic noise) and from internal machinery, normally the gearbox and, to a lesser extent, the generator (mechanical noise). The blades are carefully designed to minimize noise whilst optimising power transfer from the wind.

Noise may also be generated from ancillary equipment such as substations. However, these generally have low source noise levels as compared to wind turbines themselves and, provided they are not located within the immediate vicinity of a residential dwelling, are unlikely to cause disturbance in the context of the other noise sources. Noise from the substation has been considered as part of this assessment and is discussed further in section 7.5.2.2.

Vibration from operational wind farms is below the human threshold of perception such that no significant effects are expected. As such, this aspect of the operation of the proposed turbines is not discussed further.

7.2.2.1 Blade Swish (Amplitude Modulation of Aerodynamic Noise)

This is the periodic variation in noise level associated with turbine operation, at the rate of the blade passing frequency (rotational speed multiplied by number of blades). It is often referred to as blade swish and amplitude or aerodynamic modulation (AM). This effect is discussed in ETSU-R-97, *The Assessment and Rating of Noise from Wind Farms* (1996), upon which the Department of the Environment, Heritage, and Local Government, Wind Energy Planning Guidelines noise limits are based. ETSU-R-97 states that '*… modulation of blade noise may result in variation of the overall A-Weighted noise level by as much as 3 dB(A) (peak to trough) when measured close to a wind turbine... '* and that at distances further from the turbine where there are '… more than two hard, reflective surfaces, then the increase in modulation depth may be as much as 6 dB(A) (peak to trough)'. It concludes that 'the noise levels (i.e. limits) recommended in this report take into account the character of noise described ... as blade swish'.

An observer close to a wind turbine will experience *'blade swish'* because of the directional characteristics of the noise radiated from the trailing edge of the blades as it rotates towards and then away from them. This effect is reduced for an observer on or close to the (horizontal) turbine axis, and therefore would not generally be expected to be significant at typical separation distances, at least on relatively level sites.

In some cases amplitude modulation is observed at large distances from a wind turbine (or turbines). This is known as *'Other AM or OAM'.*

It was proposed in the RenewableUK 2013 study that the fundamental cause of OAM is transient stall conditions occurring as the blades rotate, giving rise to the amplitude modulation at the blade passing frequency. Transient stall represents a fundamentally different mechanism from blade swish and can be heard at relatively large distances, primarily downwind[2] of the rotor blade.

The University of Salford carried out a study on behalf the Department for Business, Enterprise and Regulatory Reform (BERR) (Research into aerodynamic modulation of wind turbine noise: final report, Moorhouse, AT, Hayes, M, von Hünerbein, S, Piper BJ and Adams, MD, 2007) to investigate the prevalence of amplitude modulation of aerodynamic noise on UK wind farm sites. The study concluded that AM has occurred at 4 out of 133 wind farms in the UK. A further investigation of the four sites by the Local Authority showed that the conditions associated with AM might occur between 7% and 15% of the time.

Recent research into AM was conducted by RenewableUK, 'Wind Turbine Amplitude Modulation: Research to Improve Understanding as to its Cause and Effect' (Referenced above, December 2013).

This research focused on the less understood *'Other AM or OAM'* where reported incidents are relatively limited and infrequent but is a recognised phenomenon. However, the occurrence and intensity of Other AM is specific to a location and its likelihood of occurrence cannot be reliably predicted.

Section 6 of the 'Summary of Research into Amplitude Modulation of Aerodynamic Noise from Wind Turbines - Wind Turbine Amplitude Modulation: Research to Improve Understanding as to its Cause and Effect' states that *'At present there is no way of predicting OAM at any particular location before turbines begin operation due to the general features of a site or the known attributes of a particular turbine.'*

However, the Guidance Note on Noise Assessment of Wind Turbine Operations at EPA Licensed Sites (NG3) states…

> *'features which are thought to enhance this effect are:*
>
> - *close spacing of turbines in linear rows;*
> - *tower height to rotor diameter ratio less than approximately 0.75;*
> - *stable atmospheric conditions;*
> - *topography leading to different wind directions being seen by the blades at different points in their rotation'.*

[2] The stall source mechanism radiates equally upwind and downwind, but propagation effects reduce noise levels upwind.

The Proposed Wind Farm wind turbine configuration is such that linear rows are not used. The tower height to rotor diameter ratio is met, except for the case of turbine T1, where a shorter turbine is proposed. The latter point of topography is unlikely to apply here as the site is not in a mountainous location.

The RenewableUK study *'has found that by minimising the onset of blade stall, the occurrence of OAM is also likely to be minimised.'* It goes on to discuss *'the future involvement of turbine manufacturers in developing methods of avoiding or minimising the partial stall mechanism identified as a primary cause of OAM; and suggests that in future changes to blade design and the way in which the blade pitch (the angle of attack of the blade to the incoming air flow) is controlled are likely to have a role to play in achieving better management of the phenomenon.'* Ultimately, further work is required to identify the exact on-blade conditions required for OAM to occur. The further work will aid in the development of a measure to fully mitigate the OAM. If OAM occurs from the proposed project, the wind turbine(s) will be operated in a manner to address this by way of implementation of blade pitch regulation, vortex generators or shut downs.

In 2016, the IoA published 'A Method for Rating Amplitude Modulation in Wind Turbine Noise'. It sets out a procedure for obtaining input noise data.

The procedure proposed in the IoA guidance document is recommended by the Department of Business, Energy & Industrial Strategy (BEIS) who have published a study on amplitude modulation.

It should also be noted that it is a rare event associated with a limited number of wind farms. While it can occur, it is the exception rather than the rule. The RenewableUK study states that "even on those limited sites where it has been reported, its frequency of occurrence appears to be at best infrequent and intermittent.", and "There is nothing at the planning stage that can presently be used to indicate a positive likelihood of OAM occurring at any given proposed wind farm site, based either on the site's general characteristics or on the known characteristics of the wind turbines to be installed."

Assessment of AM Research and Guidance is ongoing, with recent publications being issued by the Institute of Acoustics (IoA) Noise working Group (Wind Turbine Noise) Amplitude Modulation Working Group (AMWG) :"A Method for Rating Amplitude Modulation in Wind Turbine Noise (August 2016)". The document proposes an objective method for measuring and rating AM. The AMWG does not propose what level of AM is likely to result in adverse community response or propose any limits for AM. The purpose of the group is simply to use existing research to develop a Reference Methodology for the measurement and rating of AM. The definition of any limits of acceptability for AM, or consideration of how such limits might be incorporated into a wind farm planning condition, is outside the scope of the AMWG's work. There has been no adoption of endorsement of an AM 'penalty' scheme by any government. The IOA GPG states "The evidence in relation to "Excess" or "Other" Amplitude Modulation (AM) is still developing. At the time of writing, current practice is not to assign a planning condition to deal with AM."

Where it occurs, AM is typically an intermittent occurrence, therefore assessment may involve long-term measurements. The 'Reference Method' for measuring AM outlined in the IoA AMWG document will provide a robust and reliable indicator of AM and yield important information on the frequency and duration of occurrence, which can be used to evaluate different operational conditions which will be implemented to avoid the occurrence.

A recent study "A Review of Noise Guidance for Onshore Wind Turbines", WSP, September 2023, Department for Business, Energy & Industrial Strategy considered AM assessment for wind farm developments. It identified control of AM is a priority area of concern with the current guidance. It considered that the IOA Reference Method for AM measurement has been shown to be a robust and practical approach to quantifying AM and of the measurement methods, it offers the best balance between reliability and practicality. The report stated that reliable predictions of AM in the context of development planning and noise assessment guidance are unlikely to be practically feasible in the near future.

7.2.2.2 Infrasound and Low Frequency Noise

The definition of low frequency noise can vary, but it is generally accepted that low frequency noise is noise that occurs within the frequency range of 10 Hz to 160 Hz as defined in NANR45: Procedure for assessment of low frequency noise, Salford University Report, 2011.

Infrasound is noise occurring at frequencies below that at which sound is normally audible, i.e. at less than about 20 Hz, due to the significantly reduced sensitivity of the ear at such frequencies. In this frequency range, for sound to be perceptible, it has to be at very high amplitude and it is generally considered that when such sounds are perceptible then they can cause considerable annoyance. However, wind turbines do not produce infrasound at amplitudes capable of causing annoyance as outlined in the following paragraphs.

The UK Department of Trade and Industry study, 'The Measurement of Low Frequency Noise at Three UK Windfarms', concluded that:

> *infrasound noise emissions from wind turbines are significantly below the recognised threshold of perception for acoustic energy within this frequency range. Even assuming that the most sensitive members of the population have a hearing threshold which is 12 dB lower than the median hearing threshold, measured infrasound levels are well below this criterion.*

It goes on to state that, based on information from the World Health Organisation, 'there is no reliable evidence that infrasound below the hearing threshold produce physiological or psychological effects' and that 'it may therefore be concluded that infrasound associated with modern wind turbines is not a source which may be injurious to the health of a wind farm neighbour'.

The study reports that low frequency noise is measurable but below the DEFRA low frequency noise criterion. The study also assessed low frequency measurements against the Danish criterion of LpA,LF = 20 dB. It was found that internal levels do not exceed 20dB when measurements are undertaken within rooms with the windows closed. However, the study acknowledges that wind turbine noise (low frequency) may result in an internal noise level that is just above the threshold of audibility as defined in ISO 226. The study goes on to say… *'However, at all the measurement sites, low frequency noise associated with traffic movement along local roads has been found to be greater than that from the neighbouring wind farm.'*

Bowdler et al. (2009) concludes that *'there is no robust evidence that low frequency noise (including 'infrasound') or ground-borne vibration from wind farms generally has adverse effects on wind farm neighbours'.*

In January 2013, the Environmental Protection Authority of South Australia published the results of a study into infrasound levels near wind farms. Measurements were undertaken at seven locations in urban areas and four locations in rural areas including two residences approximately 1.5 km from the wind turbines. The study concluded *'that the level of infrasound at houses near the wind turbines … is no greater than that experienced in other urban and rural environments and is also significantly below the human perception threshold.'*

In 2016, the State Office for the Environment, Measurement and Nature Conservation of the Federal State of Baden-Württemberg in Germany published a report entitled *'Low-frequency noise incl. infrasound from wind turbines and other sources.'* It assessed infrasound and low frequency sound from wind turbines and other sources. It found that for *'the measurements carried out even at close range, the infrasound levels in the vicinity of wind turbines – at distances between 150 and 300 m – were well below the threshold of what humans can perceive in accordance with DIN 45680 (2013).'*

We conclude that infrasound noise emissions from wind turbines are significantly below the recognised threshold of perception for acoustic energy within this frequency range. Infrasound is not a source which may be injurious to the health of a wind farm neighbour.

Wind turbines may produce low frequency noise at levels above the threshold of audibility. However, there is no evidence of health effects arising from low frequency noise generated by wind turbines. Given the evidence described above, an assessment of infrasound and low frequency noise from the wind farm has been scoped out.

7.2.2.3 Tonal Noise

ETSU-R-97 describes tonal noise as *'noise containing a discrete frequency component most often of mechanical origin'.* Wind turbine sound can be tonal in some cases, for example if there is a defect in a turbine blade or a fault in the mechanical equipment such as the gearbox. Tonality from wind turbines is generally caused by structural resonances in the mechanical parts of the turbine and thus is highly specific not only to the turbine model but the specific components used, including tower height. However, a correctly operating wind turbine is not considered to have tonal sound emission. In the event of tonal noise being present and following establishment of the likely cause, this can be addressed by turbine manufacturers and/or operator as and when it occurs. The assessment of the wind turbine noise assumed that a tonal penalty is 0 dB.

7.2.2.4 BS4142 Methodology

The methodology in BS4142:2014+A1:2019 Methods for rating industrial and commercial sound has been used to assess the impact of the sound from the Proposed Substation.

This standard has a number of descriptors of the sound summarised below:

Background sound level, $L_{A90,T}$ This is the A-weighted sound pressure level that is exceeded by the residual sound at the assessment location for 90% of a given time interval, T, measured with a Fast time weighting.

Residual sound This is the ambient sound remaining at the assessment location when the specific sound (i.e the source being assessed), is suppressed to such a degree that it does not contribute to the ambient sound.

Specific Sound Level, (L_S=$L_{Aeq,Tr}$) This is the equivalent continuous A-weighted sound pressure level of the specific sound source (i.e. the source being assessed) at the assessment location over a given reference time interval T_r. The reference time interval is 1 hour during the day (07:00 to 23:00) or 15 minutes at night (23:00 to 07:00).

Rating Level ($L_{ar,Tr}$) This is the specific sound plus any adjustment for the characteristic features of the sound.

The significance of a sound of an industrial or commercial source depends on the difference between the rating level of the specific source and the background noise level and the context under which the sound occurs. Generally, the greater the difference the greater the magnitude of the impact.

- A difference of +10dB or more is likely to be an indication of a significant adverse impact, depending on the context.
- A difference of +5dB is likely to be an indication of an adverse impact, depending on the context.
- A difference of 0 dB is likely to be an indication of the specific sound source having a low impact, depending on the context.

However, it is acknowledged and stressed within the standard that the source of noise should be described and assessed both in terms of the margin above background sound and in the context of the existing sound environment, especially in instances where the existing environment may already have ambient (or residual) sound levels that are high in relation to background sound level and when existing sound is similar in character to the assessed source.

Whilst BS 4142 provides a general approach to the assessment of sound impact on residential amenity, there are no guidelines for the specific approach to be taken in particular circumstances and for acceptable criteria in terms of defining potential noise limits. In these respects, the standard is left entirely open to interpretation. However, the standard states that '*Where background sound levels and rating levels are low, absolute levels might be as, or more, relevant than the margin by which the rating level exceeds the background. This is especially true at night*'.

The previous version of BS 4142, issued in 1997 and in which a similar statement was given, contained a clarifying note stating that '*…for the purposes of this standard, background noise levels below 30 dB and rating levels below about 35 dB are considered to be very low*'.

It is therefore considered that, in general and for urban or industrialised sound environments in particular, if the rated noise level is below 35 dB L_{Aeq} then this would offer sufficient protection against noise for neighbouring residents.

7.2.2.5 Vibration

Vibration from operational wind turbines is low and will not result in perceptible levels at nearby sensitive receptors nor will the levels of vibration result in any structural damage. Research undertaken by Snow[3] found that levels of ground-borne vibration 100 m from the nearest wind turbine were significantly below criteria for 'critical working areas' given by British Standard BS 6472:1992 Evaluation of human exposure to vibration in buildings (1 Hz to 80 Hz) and were lower than limits specified for residential premises by an even greater margin. Hence, the level of vibration produced by wind turbines at this distance is low and does not pose a risk to human health.

More recently, the Low Frequency Noise Report[4] published by the Federal State of Baden-Württemberg simultaneously measured vibration at several locations, ranging from directly at the wind turbine tower to up to 285m distance from an operational Nordex N117 – 2.4 MW wind turbine with a hub height of 140.6m. The report concluded that at less than 300m from the turbine, the vibration levels had reduced such that they could no longer be differentiated from the background vibration levels.

Considering that the nearest sensitive receptor is over 640m from the nearest turbine, the level of vibration is significantly below any thresholds of perceptibility. Vibration from the turbines is too low to be perceived at neighbouring residential dwellings.

Vibration levels will also be significantly below levels that would result in damage to the nearest buildings (including farm buildings). Therefore, operational vibration has been scoped out.

[3] ETSU (1997), Low Frequency Noise and Vibrations Measurement at a Modern Wind Farm, prepared by D J Snow.

[4] Low-frequency noise incl. infrasound from wind turbines and other sources', State Office for the Environment, Measurement and Nature Conservation of the Federal State of Baden-Württemberg in Germany, 2016.

BS4142 notes that where the initial estimate of the impact needs to be modified due to the context the following needs to be considered:

1. The absolute level of the sound. Where the absolute noise levels are low, absolute noise levels may be more relevant, particularly at night.
2. Character and level of residual sound compared to character and level of specific sound.
3. Sensitivity of receptor to sound and whether design measures that improve the acoustic environment can be considered (e.g. façade insulation, ventilation or acoustic screening)

7.2.3 Decommissioning Noise and Vibration

The impacts associated with decommissioning of the project are comparable to those described for the construction phase.

7.3 Methodology

The methodology adopted for this noise and vibration assessment is as follows:

- Review of appropriate guidance, planning conditions applicable to other sites and specification of suitable construction and operational noise / vibration criteria;
- Characterisation of the receiving noise and vibration environment;
- Characterisation of the Proposed Development;
- Prediction of the noise and vibration impact associated with the Proposed Development, and;
- Evaluation of noise and vibration impacts.

7.3.1 Relevant Guidance

A list of relevant guidance documents is provided below. These have been referred to where referenced or applied in the sections hereafter.

EIA Guidance:

- Guidelines on the information to be contained in Environmental Impact Assessment Reports, Environmental Protection Agency, May 2022
- Environmental Impact Assessment of Projects - Guidance on the preparation of the Environmental Impact Assessment Report (Directive 2011/92/EU as amended by 2014/52/EU)
- Noise Modelling Standards and Technical Advice:
- International Standard ISO 9613-2: 2024 Attenuation of sound during propagation outdoors, Part 2: Engineering method for the prediction of sound pressure levels outdoors
- UK Institute of Acoustics', A Good Practice Guide to the Application of ETUS-R-97 for the Assessment at Rating of Wind Turbine Noise (2013) and supplementary notes
- British Standard BS 5228 Part 1:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites Part 1: Noise
- Irish Wind Energy Association, Best Practice Guidelines for the Irish Wind Energy Industry (2012)
- UK Department of Trade and Industry (DTI), ETSU-R-97, The Assessment and Rating of Noise from Wind Farms (1996)
- BS 4142:2014+A1:2019, Methods for rating and assessing industrial and commercial sound

Guideline Noise Levels:

- Wind Energy Development Planning Guidelines, Department of the Environment, Heritage and Local Government 2006
- Draft Revised Wind Energy Development Guidelines (December 2019), Department of Housing, Planning and Local Government, 2019;
- Kildare County Development Plan 2023 – 2029;
- Kildare Wind Energy Strategy, Appendix 2 of County Development plan 2023-2029.
- BS 5228 Part 1:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites Part 1 Noise

7.3.2 Study Area

Construction and decommissioning noise has been assessed by comparing predicted construction activities against best practice construction noise criteria at the nearest residential properties to which construction activities will be carried out. As such, if the construction noise meets the relevant noise limits at the nearest locations, it will also be below the relevant limits at more distant residential locations.

The operational noise study area has been defined as a minimum such that operational noise prediction results have been included for all residential properties with a predicted noise level greater than 35 dB LA90 (which is the lowest limit prescribed in the 2006 Department of the Environment, Heritage, and Local Government, *Wind Energy Planning Guidelines*). The study area is also in accordance with the UK Institute of Acoustics', A Good Practice Guide to the Application of *ETUS-R-97 for the Assessment at Rating of Wind Turbine Noise* (2013) whereby the guidance document defines the study area as "*the area within which noise levels from the proposed, consented and existing wind turbine(s) may exceed 35dB L_{A90} at up to 10 m/s wind speed.*"

"During scoping of a new wind farm development consideration should be given to cumulative noise impacts from any other wind farms in the locality. If the proposed wind farm produces noise levels within 10 dB of any existing wind farm/s at the same receptor location, then a cumulative noise impact assessment is necessary." There are no nearby planned, consented or operational wind farm developments meeting the criteria above and the operational study area remains at the 35 dB L_{A90} boundary.

The operational study area in terms of a 35 dB L_{A90} boundary is presented in Figure 7.1. The noise prediction was carried out using the prediction model and applying the source data and parameters as described in Section 7.5.2.1 'Operational Wind Turbine Direct Impacts'.

Since construction and operational vibration have been scoped out, there is no requirement to set study areas for each as they do not need to be appraised.

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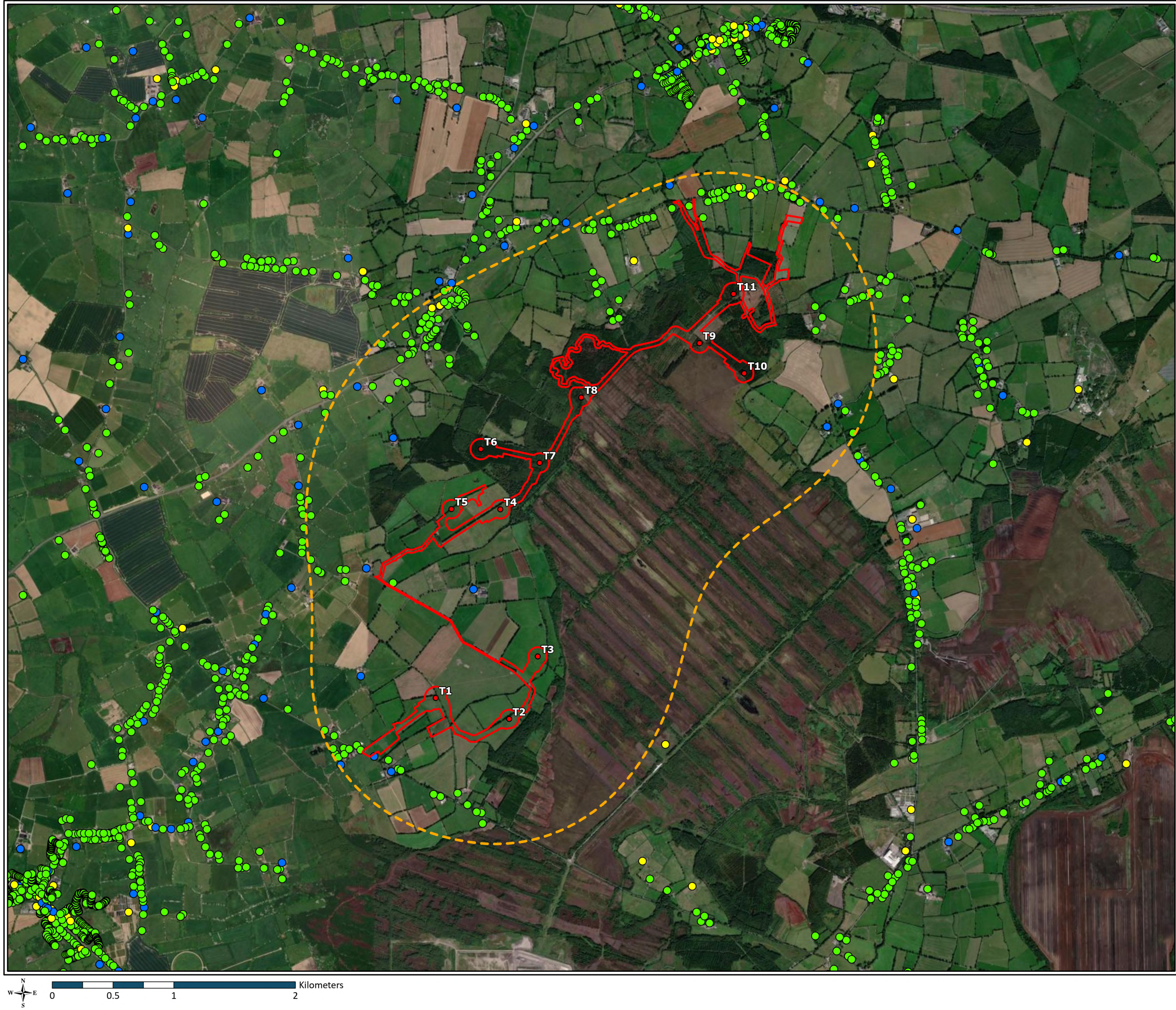

Legend

- Proposed Development Boundary
- 35dB LA90

Building Use

- Commercial
- Residentia
- Mixed-Use
- Turbine Locations

TITLE: 35dB LA90 Contour	
PROJECT: Drehid Wind Farm and Substation	
FIGURE NO: 7.1	
CLIENT: North Kildare Wind Farm Ltd.	
SCALE: 1:30,000	REVISION: 0
DATE: 01/05/2025	PAGE SIZE: A3

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7.3.3 Evaluation Criteria

7.3.3.1 Construction Noise Criteria

There is no statutory Irish guidance relating to the maximum permissible noise level that may be generated during the construction phase of a project. In the absence of specific noise limits, appropriate emission criteria relating to permissible construction noise levels for a development of this scale may be found in the British Standard *BS 5228-1:2009+A1:2014 Code of Practice for Noise and Vibration Control on Construction and Open Sites – Noise*.

BS 5228-1:2009+A1:2014 contains a number of methods for the assessment of the significance of noise effects. The ABC Method from BS 5228-1:2009+A1:2014 is used to derive appropriate noise limits for the proposed development. The threshold limits as defined in Table 7.1 based on existing ambient levels, which if exceeded, indicate a significant effect.

Table 7-1: Example Threshold of Significant Effect at Dwellings

Electoral Division of the Study Area (2022)			
Assessment Category and threshold value period (L_{Aeq})	**Category A A)**	**Category B B)**	**Category C C)**
Night-time (23:00 to 07:00hrs)	45	50	55
Evenings and weekends D)	55	60	65
Daytime (07:00 – 19:00) and Saturdays (07:00 – 13:00)	65	70	75

A) Category A: threshold values to use when ambient noise levels (when rounded to the nearest 5dB) are less than these values.

B) Category B: threshold values to use when ambient noise levels (when rounded to the nearest 5dB) are the same as category A values.

C) Category C: threshold values to use when ambient noise levels (when rounded to the nearest 5dB) are higher than category A values.

D) 19:00 – 23:00 weekdays, 13:00 – 23:00 Saturdays and 07:00 – 23:00 Sundays.

The approach adopted here calls for the designation of a noise sensitive location into a specific category (A, B or C) based on existing ambient noise levels in the absence of construction noise. For the appropriate period (e.g. daytime), the ambient noise level is determined and rounded to the nearest 5dB.

The baseline noise survey results ambient (free-field) noise levels were analysed. A correction of +3dB was added to the noise levels to convert free-field noise levels to façade noise levels. The ambient façade noise level when rounded to the nearest 5dB varies, but for the most part it is less than 60 dB L_{Aeq}. The nearest residential dwellings to the Proposed Development are afforded Category A designation (65 dB $L_{Aeq,\ 1hr}$ during daytime periods).

Section 7.5.1 provides the detailed appraisal of construction activity in relation to this site. If the modelled total noise level (including construction noise and operational noise) exceeds the appropriate category value (e.g. 65 dB $L_{Aeq,\ 1hr}$ during daytime periods) then a potential significant effect is predicted.

7.3.3.2 Windfarm Operational Noise Criteria

The operational noise assessment summarised in the following sections has been based on guidance in relation to acceptable levels of noise levels from wind farms as contained in the document *Wind Energy Planning Guidelines* published by the Department of the Environment, Heritage and Local Government (2006).

'The Assessment and Rating of Noise from Wind Farms' (1996) published by the Department of Trade & Industry (UK) Energy Technology Support Unit (ETSU) and Institute of Acoustics' A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise, (May 2013) has been used to supplement the guidance contained within the '*Wind Energy Development Guidelines'* publication where necessary.

In preparing this assessment due consideration has also been given to the Kildare County Development Plan 2023-2029. There is no specific reference to noise from windfarms, however, the Energy and Communications Chapter states:

"Aim: To encourage and support energy and communications efficiency and to achieve a reasonable balance between responding to EU and National Policies on climate change, renewable energy and communications and enabling resources to be harnessed in a manner consistent with the proper planning and sustainable development of the county". There is no specific reference to noise from windfarms

The draft Kildare County Council Noise Action Plan 2024-2028 has undergone a consultation process which ended on 27th November 2024. The final version of this has not been published at the time of writing this chapter and therefore reference is made to the current Kildare Noise Action plan 2019 to 2023.

The Kildare Noise Action Plan 2019 to 2023, (September 2019) makes reference to the 2006 wind noise criteria (Wind Energy Planning Guidelines The then Department of the Housing, Planning And Local Government (DEHLG), now the Department of Housing, Planning and Local Government (DHPLG)). Kildare Wind Energy Strategy 2023 to 2029 make reference to the Draft Revised Wind Energy Development Guidelines 2019.

The Noise action plan also refers to EPA Guidance Note on Noise Assessment of Wind Turbine Operations at EPA Licensed Sites (NG3).

Some other key aspects of the Guidelines include:

- The application of a more stringent noise limit, consistent with World Health Organisation noise standards, in tandem with a new robust noise monitoring regime, to ensure compliance with noise standards.
- The Wind Energy Strategy also sets out noise monitoring requirements for operational noise from windfarms and also construction noise monitoring.
- With respect to construction noise, the Wind Energy Strategy states:
- "• During the construction phase of works, regard should be given to the EU Noise Directive (2002/49/EC), the associated national noise regulations and any Noise Action Plans that may be prepared for the county.
- An Environmental Monitoring Report may be required during the construction phase, including mitigation measures to maintain habitats present on site in accordance with the details submitted in the EIAR and with the planning application, to be submitted to the Planning Authority at a minimum of every 12 months during construction."

The Wind Energy Strategy also mentions that cumulative impacts on population and human health shall be considered with respect to noise impacts.

"The Kildare Noise action Plan was published prior to the publication of the Draft Revised Wind Energy Development Guidelines (December 2019), Department of Housing, Planning and Local Government. The final version of these guidelines have never been published, and they are not considered best practice. They are discussed, but not used in this assessment as they do not reflect current best practice.

The Kildare Noise Action Plan 2019 to 2023 refers to the DoEHLG guidelines that contain recommended noise limits to control operational noise from wind farms and state..."*In general, a lower fixed limit of 45 dB(A) or a maximum increase of 5dB(A) above background noise at nearby noise sensitive locations is considered appropriate to provide protection to wind energy development neighbours. However, in very quiet areas, the use of a margin of 5dB(A) above background noise at nearby noise sensitive properties is not necessary to offer a reasonable degree of protection and may unduly restrict wind energy developments which should be recognised as having wider national and global benefits. Instead, in low noise environments where background noise is less than 30 dB(A), it is recommended that the daytime level of the* $L_{A90,10min}$ *of the wind energy development noise be limited to an absolute level within the range of 35-40 dB(A).*"

"*Separate noise limits should apply for day-time and for night-time. During the night, the protection of external amenity becomes less important and the emphasis should be on preventing sleep disturbance. A fixed limit of 43dB(A) will protect sleep inside properties during the night.*"

The limits are summarised below and are stated to be dB LA90,10 min values:

- 35-40 dB(A) for quiet daytime environments of less than 30 dB(A)
- For daytime environments with background noise levels greater than 30 dB(A), 45 dB(A) or 5 dB(A) above background levels whichever is greater applies
- It is stated that '*A fixed limit of 43 dB(A) will protect sleep inside properties during the night*'

In the absence of detailed guidance from the DoEHLG Wind Energy Development Guidelines 2006, best practice has typically been to consider the guidance contained in ETSU-R-97 and more recently the detailed guidance contained in the Institute of Acoustics 'A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise' (May 2013) and its six supplementary guidance notes.

Where background noise is less than 30 dB(A), an absolute level within the range of 35-40 dB(A) is applicable. However, there is no appropriate approach in relation to the identification of low noise environments "*where background noise is less than 30dB(A)*" nor is there details on the application of "*an absolute level within the range of 35-40 dB(A).*" In the absence of detailed guidance from the Wind Energy Development Guidelines 2006, on what range of 35-40 dB to use, we have referred to guidance from ETSU-R-97 which states...

"*The actual value chosen for the day-time lower limit, within the range of 35-40dB(A), should depend upon a number of factors:*

- Number of dwellings in the neighbourhood of the wind farm.
- The effect of noise limits on the number of kWh generated.
- Duration and level of exposure."

The proposed operational limits in LA90, 10 min for The Proposed Wind Farm are therefore:

- 40 dB where background levels are less than 30 dB and 45dB or 5dB above background whichever is the greater where background levels are greater than 30 dB for daytime periods and
- The greater of 43 dB or 5 dB above background for night-time periods

The 2006 DoEHLG Wind Energy Development Guidelines do not provide the specific periods which are represented by daytime and night-time hours, therefore the definitions from ETSU-R-97 are taken as 07:00 to 23:00 hrs for daytime and 23:00 to 07:00 hrs for night-time.

An Appendix to the Review of the Wind Energy Development Guidelines 2006 - Summary of Key Aspects of "Preferred Draft Approach" outlines details on noise. The proposed amendments to the Wind Energy Development Guidelines 2006 do not have statutory effect and are therefore not considered in this assessment. Nonetheless, compliance with the guidelines in-force at the time of planning grant will be demonstrated through appropriate curtailment or shut down of particular turbines during daytime or night-time periods, as appropriate.

7.3.4 Consultation Requirements

Transport infrastructure Ireland requested that "*The EIAR should consider the Environmental Noise Regulations 2006 (SI 140 of 2006) and, in particular, how the development will affect future action plans by the competent authority. The developer may need to consider the incorporation of noise barriers to reduce noise impacts (See Guidelines for the Treatment of Noise and Vibration in National Road Schemes (1st Rev., National Roads Authority, 2004)),*". There were no specific consultation requirements related to the Proposed Development.

7.4 Existing Environment

Baseline noise monitoring was undertaken at seven receptor locations surrounding The Proposed Development site to establish the existing background noise levels in the vicinity of the Proposed Development. These are some of the closest locations to the Proposed Development as well as representing different noise environments in the vicinity of the Proposed Development.

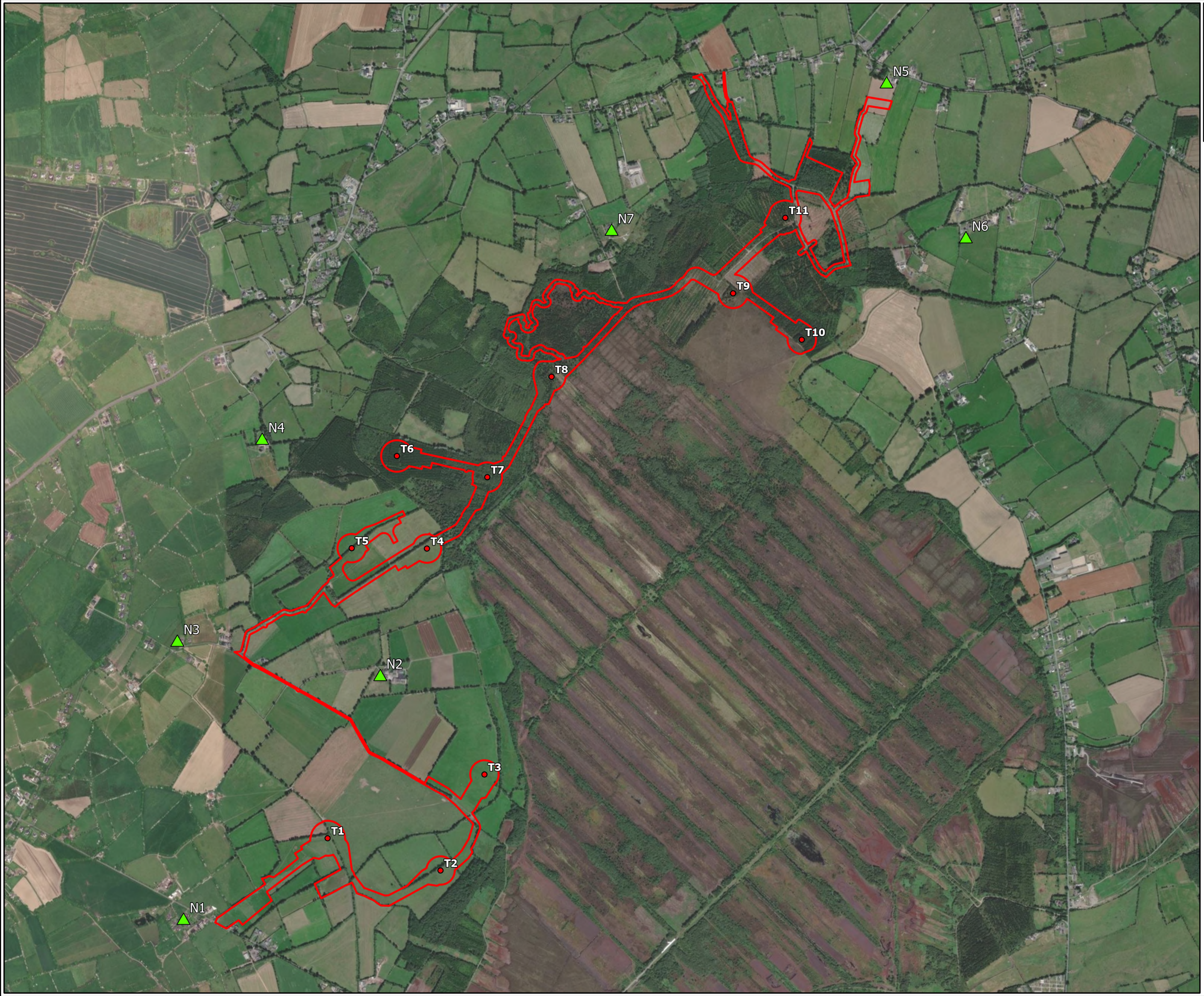
The 35dB L_{A90} study area as described in Section 7.3.2 and Figure 7.1 was reviewed to determine receivers to be considered for noise monitoring. The noise measurement locations were arranged by the developer, with FT setting up the noise monitoring equipment. Baseline noise data was collected at the seven locations, shown in Figure 7.2 and details of the noise monitoring locations are presented in Table 7.2. The rationale for the selection of these monitoring locations is described in Appendix 7.1 which presents details on the baseline measurements and data analysis.

Table 7-2: Details of Noise Monitoring Locations

Location ID	Easting	Northing	Description	Photograph
N1	673073	733924	Located to the rear of a residential property (R94) approximately 20m from the façade.	Plate 7.1-1
N2	674126	735229	Located in an agricultural field near a residential property (R74) approximately 20m from the side façade.	Plate 7.1-2
N3	673040	735413	Located in an agricultural field near the curtilage of a residential property (R70) approximately 20m from the façade.	Plate 7.1-3
N4	673494b	736494	Located to the front of a residential property (R128) approximately 20m from the façade.	Plate 7.1-4
N5	676836	738402	Located to the rear of a residential property (R208) approximately 15m from the façade.	Plate 7.1-5

Location ID	Easting	Northing	Description	Photograph
N6	677260	737573	Located on the southern boundary of garden of receptor R6, off the Dunfierth Park Road (Eircode A83 WP90), approximately 30m from the façade.	Plate 7.1-6
N7	675365	737613	Located in garden of receptor (R64), in Kilwarden townland (Eircode A83 FY68) north of the development. Measurement location is approximately 9m from the side façade.	Plate .7.1-7

Path: R:\Map Production\2022\P22-242\Workspaces\EIAR_Chapter_3_and_7\EIAR_Chapter_3_and_7.aprx



Legend

Proposed Development Boundary

Noise Monitoring Locations

Turbine Locations

TITLE: Noise Monitoring Locations	
PROJECT: Drehid Wind Farm and Substation	
FIGURE NO: 7.2	
CLIENT: North Kildare Wind Farm Ltd.	
SCALE: 1:20,000	**REVISION:** 0
DATE: 01/05/2025	**PAGE SIZE:** A3

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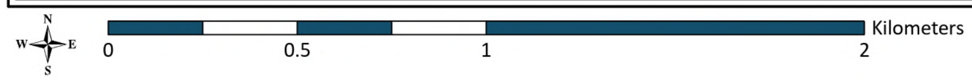

7.4.1 Analysis of the Baseline Data

The raw baseline L_{A90} noise data was reviewed to determine whether there are any periods of non-consistent noise level due to equipment malfunction. If there was any data which was inconsistent, these noise level data points were removed from the raw data. The raw noise level data was then correlated with the time synchronised 10 m standardised wind speed and rainfall data. Periods of rainfall, data affected by dawn chorus and atypical data was removed from the analysis. Once the remaining data sets were found to be representative of the noise environment, they were analysed to ensure that sufficient data sets remained to provide sufficient data coverage over the necessary wind speeds. A 'best fit' trend (not higher than a fourth order polynomial) was then derived to present the assumed prevailing background noise level at each monitoring location. Appendix 7.1 presents the results of the data analysis.

The assumed prevailing noise levels at the seven noise monitoring locations are presented in Table 7.3. Also presented is a worst-case envelope based on the lowest average levels at the various wind speeds. In some instances, the prevailing background noise is higher at lower wind speeds, in keeping with the IOA guidelines, the lowest derived background noise level is adopted for all wind speeds below where this derived minimum occurs. Furthermore, the derived prevailing background noise polynomial curve was not extended beyond the range covered by adequate data points. Where a noise limit is required at higher wind speeds; it was restricted to the highest derived point.

Table 7-3: Prevailing background noise

Location	Period	3	4	5	6	7	8	9	10	11	12
N1	Daytime	33.0	33.4	34.1	35.1	36.3	37.8	39.6	41.7	44.2	47.0
	Night time	23.7*	23.7	24.5	26.5	29.3	32.8	36.7	40.7	44.5	47.8
N2	Daytime	29.3	29.9	31.0	32.5	34.4	36.6	39.0	41.6	44.3	47.2
	Night time	20.1*	20.1	21.5	24.3	28.1	32.4	36.8	41.0	44.4	46.7
N3	Daytime	33.5	33.2	33.6	34.8	36.5	38.7	41.1	43.8	46.5	49.1
	Night time	23.4*	23.4	24.3	26.5	29.7	33.7	37.9	42.1	46.0	49.1
N4	Daytime	35.3	36.0	36.8	37.9	39.2	40.7	42.4	44.3	46.3	48.6
	Night time	26.4*	26.4	27.4	29.3	32.1	35.7	40.0	45.1	50.7	56.9
N5	Daytime	35.6	36.5	37.4	38.2	38.8	39.2	39.3	39.3	39.3	39.3
	Night time	29.5	30.3	30.7	31.3	32.5	34.8	38.8	38.8§	38.8§	38.8§
N6	Daytime	31.5	32.5	33.6	34.9	36.5	38.4	40.6	43.1	46.0	46.0§
	Night time	24.2	24.3	25.5	27.5	29.9	32.6	35.1	35.1§	35.1§	35.1§
N7	Daytime	33.4	33.8	34.4	35.2	36.4	37.7	39.2	40.9	42.8	42.8§
	Night time	25.0	25.3	26.1	27.4	29.2	31.4	33.9	33.9§	33.9§	33.9§

* - lowest derived background noise level is adopted for all wind speeds below where this derived minimum occurs. For example, at monitoring location N1 the lowest derived background noise level occurs at a wind speed of 4 m/s. The trend line fitted to noise data showed a higher noise level at 3 m/s. Therefore, using this criterion, the noise level at 3 m/s has been assumed to be equal to that of the noise level at 4 m/s.
§ - noise level restricted to the highest derived point

7.4.2 Wind Farm Noise Limits

7.4.2.1 Derived Wind Farm Noise Limits

The standard approach to derivation of noise limits is to carry out baseline measurements at a number of properties around the proposed site. Noise limits are then derived for the properties at which the measurements were carried out based on the results of these measurements. As it is not usually possible to carry out measurements at every property, properties near to the measurement property are then assigned the same limits as the measurement property. The operational impact at each of the measurement properties was appraised in accordance with the IOA GPG. As a conservative exercise, a worst-case envelope based on the lowest average noise levels at all measurement properties was used to derive a site wide noise limit and the operational impact from the wind farm was appraised.

Where low background noise levels are found, the DoEHLG guidelines recommend a limit of 35 to 40 dB L_{A90}: There is no further detail provided on which to determine how the appropriate noise limit be derived. Since this limit is clearly taken from ETSU-R-97, the IOA GPG is referred to in applying an appropriate fixed limit. ESTU-R-97 initially recommended that the following three factors be considered when determining the fixed limit:

1) the number of noise-affected properties;
2) the potential impact on the power output of the wind farm; and
3) the likely duration and level of exposure.

If we consider the mid-point of this range, 37.5dB, as the initial value to apply the factors, the first factor to be considered is the "number of noise-affected properties". ETSU-R-97 describes this factor as balancing the benefits from a wind energy project with the local environment impact, "*The more dwellings that are in the vicinity of a wind farm the tighter the limits should be as the total environmental impact will be greater. Conversely if only a few dwellings are affected, then the environmental impact is less and noise limits towards the upper end of the range may be appropriate.*" The number of noise sensitive locations (includes planning permissions) within the 35dB $_{LA90}$ study area is 152, therefore the limit is decreased towards the lower range level of 35dB(A).

The second factor is the effect of noise limits on the power output of the wind farm. Similarly, to the first factor, this balances the planning merit of the project against the local impact. If the limit is lowered, then, based on the noise modelling results, no turbine would need to be curtailed or removed to meet said limits at dwellings. Since this project is considered to have merit in assisting Ireland in meeting its renewable energy targets, consideration of this factor allows for the limit to also be increased.

The final factor relates to the duration and level of exposure. The prevailing background noise levels are described in detail in Section 7.4.1 and Appendix 7.1:

- Only monitoring location N2 had daytime background noise levels less than 30 dB L_{A90} at a 10 m standardised wind speed of 3 m/s and 4 m/s. All other monitoring locations had daytime background noise levels greater than 30 dB L_{A90}.
- All monitoring locations had daytime background noise levels greater than 30 dB L_{A90} at a 10 m standardised wind speed of 5 m/s.

A review of the three factors to determine the fixed noise limit where low background noise levels are found, indicate that the higher range of 40 dB is an appropriate and valid limit to apply based on the rationale described above especially given that only one monitoring location had background noise levels less than 30 dB L_{A90} at a 10 m standardised wind speed of 3 m/s and 4 m/s.

The derived noise limits, according to the discussion within Section 7.3.3.2 Wind Farm Operational Noise Criteria with reference to the background noise environment found at dwellings surrounding the Proposed Development site and, where necessary, the meteorological conditions experienced during the survey are presented in Table 7.4. A worst-case envelope based on the lowest average noise levels at the various wind speeds are also presented in Table 7.4. The noise limits derived using the baseline noise envelope are considered a worst case and conservative approach to this aspect of the assessment. The measurement data indicates that the envelope prevailing background noise levels are below 30 dB L_{A90} for measured 10 m standardised wind speeds up to and including 4 m/s. As a result, it is proposed that a fixed 40 dB L_{A90} daytime noise limit corresponding to low background noise levels is applied at this site for measured 10 m standardised wind speeds up to 4 m/s and 45 dB L_{A90} thereafter, with a limit of 5 dB above background applied at higher windspeeds. A fixed 43 dB L_{A90} noise limit or 5 dB above background whichever is greater is proposed for night-time periods. The assessment uses more onerous limits than those in the wind energy development guidelines to demonstrate the site can meet these limits. However, the noise limits that will apply to the site are the wind energy development guidelines noise limits.

Table 7-4: Derived noise limits

Location	Period	3	4	5	6	7	8	9	10	11	12
N1	Daytime	45.0	45.0	45.0	45.0	45.0	45.0	45.0	46.7	49.2	52.0
	Night time	43.0	43.0	43.0	43.0	43.0	43.0	43.0	45.7	49.5	52.8
N2	Daytime	40.0	40.0	45.0	45.0	45.0	45.0	45.0	46.6	49.3	52.2
	Night time	43.0	43.0	43.0	43.0	43.0	43.0	43.0	46.0	49.4	51.7
N3	Daytime	45.0	45.0	45.0	45.0	45.0	45.0	46.1	48.8	51.5	54.1
	Night time	43.0	43.0	43.0	43.0	43.0	43.0	43.0	47.1	51.0	54.1
N4	Daytime	45.0	45.0	45.0	45.0	45.0	45.7	47.4	49.3	51.3	53.6
	Night time	43.0	43.0	43.0	43.0	43.0	43.0	45.0	50.1	55.7	61.9
N5	Daytime	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0
	Night time	43.0	43.0	43.0	43.0	43.0	43.0	43.8	43.8	43.8	43.8
N6	Daytime	45.0	45.0	45.0	45.0	45.0	45.0	45.6	48.1	51.0	51.0
	Night time	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
N7	Daytime	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.9	47.8	47.8
	Night time	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0

Location	Period	3	4	5	6	7	8	9	10	11	12
Envelope	Daytime	40.0	40.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0
	Night time	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.8	43.8	43.8

* - lowest derived background noise level is adopted for all wind speeds below where this derived minimum occurs. For example, at monitoring location N1 the lowest derived background noise level occurs at a wind speed of 4 m/s. The trend line fitted to noise data showed a higher noise level at 3 m/s. Therefore, using this criterion, the noise level at 3 m/s has been assumed to be equal to that of the noise level at 4 m/s.
§ - noise level restricted to the highest derived point

7.5 Potential Impacts

7.5.1 Potential Impacts during Construction

7.5.1.1 Potential Direct Impact

The predicted construction noise levels at the nearby noise sensitive locations were calculated in accordance with BS 5228-1:2009+A1:2014. BS 5228-1:2009+A1:2014 sets out sound power levels and L_{Aeq} noise levels of plant items normally encountered on construction sites, which in turn enables the prediction of noise levels at selected locations.

BS 5228-1:2009+A1:2014 also sets out a number of methods predicting construction noise levels. Methods are presented for stationary and quasi-stationary activities and for mobile plant using a regular well-defined route (e.g. haul roads). The predictions account for source-receiver distance, reflections and screening or soft ground attenuation and some methods include a percentage on-time.

Construction noise predictions are based on information contained in the outline construction programme. Noise predictions have been calculated for a number of tasks. For each task a set of assumed plant with noise data taken from BS5228:2009+A1:2014, *Code of practice for noise and vibration control on construction and open sites* has been used. Noise predictions were carried out using guidance from BS5228:2009+A1:2014. The ground cover is predominately acoustically soft (G=1). The noise model assumes that the ground cover is a mix between hard and soft ground with a ground cover of G=0.75 used in the noise model. Percentage on time for plant is outlined for each of the assumed plant.

The construction noise model appraised a number of tasks with the potential to generate noise. These tasks included: deliveries and/or removal of material to and from site, preparation of access roads and drainage, piling of foundations, concrete mixing and pouring of foundations, preparation of hardstands and drainage, installation of wind turbines, works associated with grid connection and construction of berms.

Site Traffic

Detailed information on construction traffic is presented in Chapter 13. To summarise, additional light goods vehicles travelling to and from the site during the construction phase would be expected to peak during the morning (arrival of contractors at the site) and evening (departure of contractors from the site) and are envisaged not to be a continuous source of noise emissions from the site during a typical working day. The impact from construction personnel movements to and from the site is expected to be low.

All deliveries of turbine components and other construction materials to the site will only be by way of the proposed transport route outlined in Chapter 13. The most intensive period of the works programme will be Month 3. The busiest weeks are weeks 7-12, when site roads and hardstanding works will be ongoing in parallel. Over a six-day week, the maximum daily traffic would therefore be approximately 311 two-way HGV trips. There are potential traffic noise impacts during the construction phase especially on local roads (L5025) where the do nothing scenario volumes are low. It is likely that turbine deliveries may be carried out at night, and that pouring concrete for the turbine foundations may have to also be carried out at night.

The noise impact for construction works traffic would be mitigated by generally restricting movements along access routes to the standard working hours and exclude Sundays, unless specifically agreed otherwise. For example, during turbine erection, an extension to the working day may be required, i.e 05:00 to 21:00, but this would be necessary only on a relatively small number of occasions. Where works are required at night, such as turbine deliveries or concrete pouring, it will be subject to agreement with the relevant planning authority.

For night time turbine deliveries it would be ensured that vehicles on local roads do not wait outside residential properties with their engines idling, and that the local residents will be informed of any activities likely to occur outside of normal working hours.

Construction activities associated with the turbine delivery route are summarised in Section 3.4.4.1 (Chapter 3 of this EIAR). There are fifteen points of interest, where some construction activities are required along the route. In general, the nature of these works are minor, e.g. vegetation trimming, sign removal, clearance of overhead utilities. Given the nature of works associated with the TDR route is minor and will take place over a short duration, only construction associated with the access road in the northern part of the site required for the Turbine Delivery is considered below, as part of the turbine delivery works.

Tree Felling

Some of the turbines are located within forested areas. Therefore, tree felling will be required to create a clearing for the turbine construction, hardstandings and crane pads. Noise from construction works associated with tree felling has been considered, based on tree felling at Turbines 6, 7, 8, 9, 10 and 11. In addition, tree felling is required for some access tracks, including the area between Turbines 8 and 9.

Table 7.5 presents the predicted noise levels from this activity at the nearest dwelling. Assuming all plant is operating, the predicted cumulative noise at the closest noise sensitive location R61 (approximately 280m from the proposed works) is 53.0 dB $L_{Aeq,1hr}$. Therefore, the predicted noise at the nearest noise sensitive location is below the daytime noise limit of 65 dB $L_{Aeq,1hr}$. The noise associated with the felling activity is expected to have a slight impact and be temporary in duration. Also presented in Table 7.5 is noise at a noise sensitive location close to the access track at the site entrance, (R134, family member of an involved landowner), which is approximately 25m from the access track, at the closest point. The predicted noise at this location is 2.2 dB above the daytime noise limit of 65 dB $L_{Aeq,1hr}$. Note that the main site access road has been re-aligned eastwards to remove the construction noise impact at the closest property west of the site entrance. However, the effect of this is to increase the impact at R134, east of the site entrance. The predicted noise at other noise sensitive locations in this area are below 65 dB $L_{Aeq,1hr}$.

Table 7-5: Tree Felling – Likely Plant and Predicted Noise Levels

Plant	BS 5228 Ref.	Activity	Percentage on-time (%)	Predicted Noise Level at R61	Predicted Noise Level at R134 (family member of involved landowner)
Harvester §	C2.5	Harvesting trees	80	45.1	17.8
Forwarder µ	C4.53	Moving felled trees	80	45.7	18.3
Lorry *	C11.9	Transporting timber and brash off site	311 two way trips	51.1	67.2
Cumulative				53.0	67.2

* Drive-by maximum sound pressure level
§ - Excavator BS 5228 Ref C2.5
µ - Lorry with lifting boom – C4.53

Preparation of Access Roads, Hardstandings and Drainage

The access roads and hardstanding areas consist of levelled and compacted hard core. Table 7.6 presents the predicted noise levels from this activity at the closest residential location to the north (approximately 180m from the internal track to loop in connecter), centre (approximately 280m from access road between Turbines 8 and 9) and south of the site (approximately 48 m from southern entrance [for a non-involved landowner])). Note that the family member of a landowner (R134) is located approximately 25m from the access track at the closest point. Assuming all construction activities occur simultaneous the predicted noise level from the construction activities at the closest noise sensitive locations at distances of 25m, 180m and 280m at the nearest residential dwellings are 74.6 dB LAeq,1hr, 56.4 dB LAeq,1hr and 53.3 dB LAeq,1hr, respectively. The predicted noise at the nearest noise sensitive location (R134), at the site entrance is 9.6 dB above the limit during access track construction works at the closest point. Again this access track has been re-aligned to reduce the impact at the property west of the site entrance. The predicted noise level at the remaining noise sensitive locations meet the daytime 65 dB LAeq,1hr noise limit.

Mitigation measures to minimise the noise impact at the nearest noise sensitive location are discussed in Section 7.6.1.

Table 7-6: Preparation of Access roads, Hardstands and Drainage assumed plant

Plant	BS5228 Ref	Activity	Percentage on-time (%)	Predicted noise level at		
				R30 North of site (180m)	R61 Centre of site (280m)	R134 Southern site entrance (25m)
Tracked Excavator (25t)	C2.19	Ground excavation/ earthworks	80	50.7	46.1	70.5
Articulated Dump Truck (23t)	C2.32	Tipping Fill	20	41.2	36.6	61
Dozer (14t)	C5.12	Spreading chipping/fill	80	49.9	45.3	69.7
Vibratory roller (3t)	C5.27	Rolling and Compaction	80	39.8	35.2	59.6
Excavator (21t)	C4.65	Trench for drainage	80	44.5	39.9	64.3
Lorry*	C11.9	Delivery of Material	311 two way trips per day	52.4	50.9	65.2
Cumulative				56.4	53.3	74.6
* - Drive-by maximum sound level						

An access road is proposed to the north of the site, to be used for delivery of oversized turbine components only. Table 7.7 presents the predicted noise levels from this activity at the closest residential location (R31) to the north east (approximately 45m from works) and a second location R32, to the north west (approximately 70m from the proposed works).Rather than assuming the maximum number of vehicles per day arriving at site, a more realistic assumption was made for the vehicle numbers that will be associated with this short section of access tracks. Based on the length of track here, and the volume of stones required, it is assumed that a maximum of 83 lorries per day will be active in this location, rather than the maximum 311 which will enter the main site entrance. Assuming all construction activities occur simultaneous the predicted noise level from the construction activities at the closest noise sensitive location (R31) is 69.0 dB LAeq,1hr and exceeds the noise limit by 4dB. The predicted noise at R32 is 65.8dB and therefore marginally exceeds the noise limit. The predicted noise level at the remaining noise sensitive locations meet the daytime 65 dB LAeq,1hr noise limit.

The predicted noise level from the TDR access road in this location can meet the noise limit, if works are phased (so no two items of plant operating at once). Alternatively, site hoarding between the noise sensitive locations and the works may be considered. Mitigation measures to minimise the noise impact at the nearest noise sensitive location are discussed in Section 7.6.1.

Table 7-7: Preparation of Access roads to the North of the Site

Plant	BS5228 Ref	Activity	Percentage on-time (%)	Predicted noise level at	
				R31 (45m)	R32 (70m)
Tracked Excavator (25t)	C2.19	Ground excavation/ earthworks	80	64.9	58.8
Articulated Dump Truck (23t)	C2.32	Tipping Fill	20	55.4	49.4
Dozer (14t)	C5.12	Spreading chipping/fill	80	64.1	58
Vibratory roller (3t)	C5.27	Rolling and Compaction	80	54	47.9
Excavator (21t)	C4.65	Trench for drainage	80	58.7	52.6
Lorry*	C11.9	Delivery of Material	83 two way trips per day	59.4	63.2
Cumulative				69.0	65.8
* - Drive-by maximum sound level					

Preparation of Wind Turbine Foundations Assumed Plant
A tracked excavator will strip overburden from the foundation area and this material will be stockpiled on same property. The next stage will involve a crane lifting reinforcing steel to the required areas. Once the steel is in place, concrete will be poured using a concrete pump. Once the concrete foundation has sufficient curing time it will be filled with suitable fill up to existing ground level. In addition, it is proposed that piling will be required at turbines T8, T9 and T10. For the foundation works at these turbines, hydraulic hammered piling has been assumed. This is the noisiest type of piling and would therefore represent a worst case scenario. Table 7.8 presents the predicted noise levels from this activity at closest occupied dwellings to the non-piled turbine foundation and the piled turbine foundation.

Table 7-8: Preparation of Wind Turbine Foundations Assumed Plant

Plant	BS5228 Ref	Activity	Percentage on-time (%)	Predicted noise level at R35 Non-piled option (at ~660m)	predicted noise level at R65 Piled option (at ~650m)
Tracked Excavator (25t)	C2.19	Ground excavation/earth works	80	37.4	37.7
Excavator (23t)	C10.8	Loading sand / soil	80	40.1	40.4
Diesel Pump	C4.88	Pump water	100	29.7	30
Tubular Steel Piling – Hydraulic Hammer (4t hammer)	C3.2	Piling	80	-	47.5
Mobile telescopic crane	C4.41	Lifting reinforcing steel	80	31.1	31.4
Concrete mixer truck & concrete pump	C4.28	Concrete mixer truck (discharging) & concrete pump (pumping)	100	35.7	36
Lorry*	C11.9	Delivery and removal of material	311 two-way trips per day	45.8	45.6
Cumulative				47.8	50.6
* - Drive-by maximum sound level					

Not all activities outlined in Table 7.8 will occur simultaneously and those that do, have a cumulative noise level of less than 50.6 dB $L_{Aeq,1hr}$ which is below the 65 dB $L_{Aeq,1hr}$ noise limit.

Works on the foundations of all turbines require access via internal access roads and the predicted noise level resulting from lorries is 2 dB above the 65 dB $L_{Aeq,1hr}$ noise limit, at the site entrance, at R134. As described earlier this is a family member of an involved landowner and mitigation measures to minimise the noise impact at this noise sensitive location are discussed in Section 7.6.1.

Erection of Wind Turbines

Turbine components will be delivered to site to the blade deposit area, near the southern site entrance. The turbine components will then be delivered to the turbine hardstand area and a mobile telescopic crane will lift the turbine components into place. A worst case of the crane lifting turbine components 100% of the time is assumed along with delivery of turbine components. The assessment assumes that the turbine parts will be delivered to turbines 1,2 and 3 via the southern entrance, and delivered via the access track to the north of the site for the remaining turbines. The predicted noise levels are presented in Table 7.9. The predicted cumulative noise level is 65.2 dB $L_{Aeq,1hr}$ at the most affected location, near to the northern turbine delivery site entrance and access track. This is marginally (0.2dB) above the 65 dB $L_{Aeq,1hr}$ noise limit. Mitigation measures to minimise the noise impact at the nearest noise sensitive location are discussed in Section 7.6.1.

Table 7-9: Installation of Wind Turbine Assumed Plant

Plant	BS5228 Ref	Activity	Percentage on-time (%)	Predicted noise level at R31 (near northern site entrance)
Mobile telescopic crane	C4.41	Lifting turbine components	100	30.1
Lorry *	C11.9	Delivery of Turbine Components	311 two-way trips per day	65.2
Cumulative				65.2
* - Drive-by maximum sound level				

Construction of Substation

The construction of the substation will occur during the construction phase of the Proposed Development. The construction works will be progressed in a number of phases:

- Site clearance
- Preparation and pouring of foundations and floor areas
- Preparation of subbases, hardstanding areas and pouring of concrete
- Erection of steel work

Table 7.10 presents the assumed plant required for the different phases of the construction of the proposed buildings on site.

For this assessment the nearest occupied dwellings are assumed to be approximately 600m from the centre of the proposed substation works. The closest noise sensitive locations to the substation will be R35 (north west of the substation) and R56 (south east of substation). The predicted noise levels are significantly below the construction noise limit of 65 dB $L_{Aeq,1hr}$.

Table 7-10: Typical noise levels during construction works

Phase	Plant	BS5228 Ref	Activity	Percentage on-time (%)	Predicted noise level at R35 at 600 m	Predicted noise level at R56 at 590 m
Site Clearance and Preparation	Tracked excavator (22t)	C2.3	Clearing Site	80	42.1	42.2
	Dozer (11t)	C2.12	Ground excavation/ earthworks	80	41.8	41.8
	Cumulative				45.0	45.0
Preparation and pouring of foundations	Tracked Excavator (25t)	C2.19	Ground excavation/ earthworks	80	38.6	38.7
	Concrete mixer truck & concrete pump	C4.28	Concrete mixer truck (discharging) & concrete pump (pumping)	80	36	36.1
	Lorry*	C11.9	Delivery of material	311 two way trips per day	47.9	47.3
	Cumulative				48.2	47.6
Preparation of hardstanding areas	Tracked Excavator (25t)	C2.19	Ground excavation/earthworks	80	38.6	38.7
	Articulated Dump Truck (23t)	C2.32	Tipping Fill	20	29.1	29.2
	Dozer (14t)	C5.12	Spreading chipping/fill	80	37.8	37.9
	Vibratory roller (3t)	C5.27	Rolling and Compaction	80	27.7	27.8
	Lorry*	C11.9	Delivery of material	311 two way trips per day	47.9	47.4
	Cumulative				48.8	48.4
Erection of blockwork/installation concrete slabs	Mobile telescopic crane (80t)	C4.39	Lifting concrete slabs	80	37.8	37.9
	Lorry* (32t)	C11.9	Delivery of material	311 two way trips per day	47.9	47.4
	Cumulative				48.3	47.9
General Construction including installation of	Generator	C4.84	Power for site cabins	100	35.7	35.7

Phase	Plant	BS5228 Ref	Activity	Percentage on-time (%)	Predicted noise level at	Predicted noise level at
					R35 at 600 m	R56 at 590 m
electrical and mechanical plant	Telescopic handler	C4.54	Lifting Plant	80	39.8	39.8
	Angle grinder (grinding steel)	C4.93	Miscellaneous	80	41.7	41.7
	Cumulative				44.5	44.5
* - Drive-by maximum sound level						

Grid Connection Works

Each turbine will be connected to the on-site electricity substation via an underground medium voltage electricity cable. There is a proposed on-site connection between the on-site substation and a loop-in/loop out infrastructure connection to the 110kV Kinnegad-Rinwade overhead line, within the site boundary. Two main construction activities have been considered as part of the grid connection works: noise from the underground site connection works and from installation of two masts for connection with the existing overhead line. The plant assumed for these two activities are presented in Table 7.11.

Table 7-11: Preparation of underground section of Grid connection assumed plant

Plant	BS5228 Ref	Percentage on-time (%)	Activity	A-Weighted Sound Pressure Level, L_{Aeq}, dB
				145m
Equipment for Underground Grid Connection Works				
Road sweeper	C4.90	10	Sweeping and dust suppression	42.7
Mini excavator with hydraulic breaker	C5.2	25	Breaking Road Surface	53.3
Vibratory roller	C5.27	50	Rolling and Compaction	40.4
Wheeled excavator	C5.34	50	Trenching	43.8
Hand-held circular saw (petrol)	C5.36	10	Cutting Concrete Slabs	53.4
Dump truck (tipping fill)	C2.30	10	Tipping Fill	46.9

Plant	BS5228 Ref	Percentage on-time (%)	Activity	A-Weighted Sound Pressure Level, L_{Aeq}, dB
				145m
Vibratory plate (petrol)	C2.41	10	Compaction	46.9
Cumulative				57.7
Equipment for Mast foundation and OHL installation				
Tractor and Trailer	C3.75	80	Moving materials	55.1
Crane	C4.41	80	Lifting	25.3
Teleporter	C2.35	80	Lifting	46.4
Chains/small tools	C3.35	10	Cutting metal	31.7
Tracked excavator	C2.3	80	Ground works	53.8
Tracked dumper	C2.19	80	Removing fill	53.3
Sheet piling	C3.8	10	Shutter piles	54.7
Concrete truck discharging	C4.32	50	Mast foundation	51.6
Cumulative				61.0

Table 7.11 presents the predicted noise level for the two main grid connection activities at the nearest noise sensitive location, north of the works at a distance of approximately 145 m from the works. The noise levels presented are predicted maximum expected levels. The duration of the grid connection works (in addition to the substation works is for a 36 week period approx). Noise from the works at the closest property is less than the daytime noise limit of 65 dB $L_{Aeq,1hr}$.

Construction of Berms

Peat excavated for the construction of the Proposed Development will be re-used on site in berms and for landscaping purposes. The location of berms is illustrated on Figure 3.9 in Chapter 3. Table 7.12 presents the predicted noise levels from this activity at a distance of 590m from the berm construction works, which represents the closest property (R35) to the large berms in clearfell areas. Table 7.12 presents the predicted noise levels at a distance of 590m from the works. At this distance noise at the closest noise sensitive location is within the daytime limit of 65 dB $L_{Aeq,1hr}$.

Table 7-12: Construction of Berms

Plant	BS5228 Ref	Activity	Percentage on-time (%)	Predicted noise level at (R35) at 590 m
Articulated dump truck (23t) *	C2.33	Distribution of Material	4 two-way trips per hour	32.2
Articulated dump truck (tipping fill)	C2.32	Tipping Fill	20	30.6
Dozer	C2.12	Material Distribution/Placement	80	30.6
Tracked Excavator	C2.19	Material Distribution/Placement	80	32.2
Cumulative				37.5

7.5.1.2 Potential Cumulative Impacts

There are not expected to be any significant cumulative noise impacts associated with the construction of The Proposed Wind Farm. There are no proposed projects expected to be constructed in close proximity to the Proposed Development, where construction works would proceed at the same time.

7.5.2 Potential Impacts during Operation

7.5.2.1 Operational Wind Turbine Direct Impact

Noise predictions have been carried out using International Standard ISO 9613, *Acoustics – Attenuation of Sound during Propagation Outdoors*. The propagation model described in Part 2 of this standard provides for the prediction of sound pressure levels based on either short-term downwind (i.e. worst case) conditions or long term overall averages. Only the worst-case downwind condition has been considered in this assessment, that is – for wind blowing from the proposed turbines towards the nearby houses. When the wind is blowing in the opposite direction noise levels may be significantly lower, especially where there is any shielding between the turbines and the houses.

The ISO propagation model calculates the predicted sound pressure level by taking the source sound power level for each turbine in separate octave bands and subtracting a number of attenuation factors according to the following:

Predicted Octave Band Noise Level = $L_W + D - A_{geo} - A_{atm} - A_{gr} - A_{bar} - A_{misc}$

These factors are discussed in detail below. The predicted octave band levels from the turbine are summed together to give the overall 'A' weighted predicted sound level.

L_W - Source Sound Power Level

The sound power level of a noise source is normally expressed in dB re:1pW. Noise predictions are based on sound power levels provided for the Nordex 133 with a hub height of 100.5 m for all turbines, with the exception of T1 which has a hub height of 81.4m.

D – Directivity Factor

The directivity factor allows for an adjustment to be made where the sound radiated in the direction of interest is higher than that for which the sound power level is specified. In this case the sound power level is measured in a downwind direction, corresponding to the worst-case propagation conditions considered here and needs no further adjustment.

A_{geo} – Geometrical Divergence

The geometrical divergence accounts for spherical spreading in the free-field from a point sound source resulting in attenuation depending on distance according to the following:

- A_{geo} = 20 x log(d) + 11
- where, d = distance from the turbine

A wind turbine may be considered as a point source beyond distances corresponding to one rotor diameter.

A_{atm} - Atmospheric Absorption

The atmospheric absorption accounts for the frequency dependant linear attenuation with distance of sound power over the frequency spectrum according to:

- A_{atm} = d x α
- where, α = the atmospheric absorption coefficient of the relevant frequency band

Published values of 'α' from ISO9613 Part 1 have been used, corresponding to a temperature of 10^oC and a relative humidity of 70%, the values specified in the IOA GPG, which give relatively low levels of atmospheric attenuation, and subsequently conservative noise predictions as given in Table 7.13.

Table 7-13: Preparation of Access roads, Hardstands and Drainage assumed plant

Octave Band Centre Frequency (Hz)							
63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	8 kHz
0.00012	0.00041	0.00104	0.00193	0.00366	0.00966	0.03280	0.11700

A_{gr} - Ground Effect

Ground effect is the interference of sound reflected by the ground with the sound propagating directly from source to receiver. The prediction of ground effects is inherently complex and depend on the source height, receiver height, propagation height between the source and receiver and the ground conditions.

The ground conditions are described according to a variable G which varies between 0 for 'hard' ground (includes paving, water, ice, concrete and any sites with low porosity) and 1 for 'soft' ground (includes ground covered by grass, trees or other vegetation). The GPG states that use of G = 0.5 and a receptor height of 4 m should be used to predict the resultant turbine noise level at dwellings neighbouring a proposed development provided that an appropriate allowance for measurement uncertainty is accounted for within the stated source noise levels. Therefore, predictions in this report are based on G = 0.5 with a receptor height of 4 m and, due to the inclusion of the assumed uncertainty within the source noise levels, these predictions are considered to be conservative.

A_{bar} - Barrier Attenuation

The effect of any barrier between the noise source and the receiver position is that noise will be reduced according to the relative heights of the source, receiver and barrier and the frequency spectrum of the noise. The barrier attenuations predicted by the ISO 9613 model have, however, been shown to be significantly greater than that measured in practice under downwind conditions. The results of a study of propagation of noise from wind farm sites carried out for ETSU concludes that an attenuation of just 2 dB(A) should be allowed where the direct line of site between the source and receiver is just interrupted and that 10 dB(A) should be allowed where a barrier lies within 5 m of a receiver and provides a significant interruption to the line of site.

The IOA GPG states that 'Topographic screening effects of the terrain (ISO 9613-2, Equation 2) should be limited to a reduction of no more than 2 dB, and then only if there is no direct line of sight between the highest point on the turbine rotor and the receiver location'. There are no significant topographical barriers surrounding the proposed site. As a result, this has not been accounted for within the predictions.

A_{misc} – Miscellaneous Other Effects

ISO 9613 includes effects of propagation through foliage and industrial plants as additional attenuation effects. The attenuation due to foliage has not been included here and any such effects are unlikely to significantly reduce noise levels below those predicted.

Predicted Noise Levels

The predicted turbine noise L_{Aeq} has been adjusted by subtracting 2 dB to give the equivalent L_{A90} as suggested in the IoA GPG. It should be noted that noise levels will be lower at lower wind speeds.

Overview of Input Datasets

In order to calculate the noise levels at noise sensitive locations, an accurate representation of the source and receiver positions was necessary for the prediction modelling. The turbine locations are presented in Table 3.1 (Chapter 3) and noise sensitive locations are presented in Appendix 7.4.

For the purposes of this assessment, noise predictions are based on sound power levels provided for the Nordex 133/4.8.

The apparent sound power level values for the turbine are based on the noise levels provided by the manufacturer (Document ref: Octave Sound Power Levels -F008_272_A14_EN Rev 04, 2021-05-19).

The manufacturers' data is presented for integer hub heights, standardised to 10m height. The proposed 81.4m and 100.5m turbines are not a standard height for this turbine type. As the manufacturers noise data increases with hub height, for the purpose of this assessment the noise data for the 110m turbine height has been assumed, which represents a worst case scenario.

The sound power levels are presented in Table 7.14.

It is possible to run all turbine models in noise reduced modes of operation (NROs) whereby the noise level is lessened by reducing the rotational speed of the turbines, with a resultant loss of electrical energy production.

The IOA GPG states that it should be ensured that a margin of uncertainty is included within source wind turbine noise data used in noise predictions.

Table 7-14: Manufacturer Wind Turbine Sound Power Levels (Nordex 133/4.8), dB LWA, at standardized wind speeds, based on a height of 110m, Mode 0, with trailing edge serration

Turbine	Octave Band Centre Frequency (Hz)							
	3	4	5	6	7	8	9	10 – cut out
N133/4.8	93	95	100.6	104.3	104.5	104.5	104.5	104.5

The assumed octave band spectra used for the noise predictions are shown in Table 7.15 and are based on information produced by the manufacturer, normalised to the sound power levels in Table 7.14, corresponding to standardised 10 m height wind speeds of 3 m/s to greater than 10 m/Cs.

Table 7-15: Manufacturer Wind Turbine (Nordex N133/4.8) Octave Band Noise Levels, dB LWA for a range of standardized 10m height wind speeds (m/s) from 3m/s to cut out, based on data from an 110m hub height turbine

Normal Operation								
10m Standardised windspeed (m/s) Frequency (Hz)	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10 – cut out**
32	64	66	71.6	75.3	75.5	75.5	75.5	75.5
63	74.7	76.7	82.3	86	86.3	86.2	86.2	86.2
125	81.7	83.7	89.3	93	93.3	93.2	93.2	93.2
250	85.5	87.5	93.1	96.8	97.1	97	97	97
500	86.4	88.4	94	97.7	98	97.9	97.9	97.9
1000	86.9	88.9	94.5	98.2	98.4	98.4	98.4	98.4
2000	85.6	87.6	93.2	96.9	97.2	97.1	97.1	97.1
4000	81.3	83.3	88.9	92.6	92.9	92.8	92.8	92.8
8000	72.1	74.1	79.7	83.4	83.7	83.6	83.6	83.6
Total Sound Power Level (dB)	93	95	100.6	104.3	104.5	104.5	104.5	104.5

Noise Predicted Results

Noise predictions were performed for the 11 wind turbine layout modelling Nordex N133/4.8 wind turbines for a range of standardised 10m height wind speeds from 3 m/s up to 10 m/s – cut-out. Receptors within the 35 dB L_{A90} noise contour of the turbines were modelled. A number of the receptors were identified as commercial/farm buildings or unoccupied derelict buildings and these have not been considered as part of the impact assessment and were not assessed against the derived daytime and night-time noise levels. Two commercial properties in the village of Kilshanroe, which are just within the 35 dB L_{A90} noise contour have been considered as noise sensitive locations, as these are schools. Noise predictions for all noise sensitive locations are presented in Appendix 7.4.

The predicted operational noise levels at occupied dwellings or planning applications for dwellings with the highest predicted noise levels are presented in Table 7.16. The predicted noise levels at all receptor locations are presented in Appendix 7.4. Note: the predicted noise levels are for a worst-case scenario with noise sensitive receptors downwind of the proposed wind farm. In practice, receptor locations will not be downwind of all wind turbines and the actual noise levels will be lower than those presented in Table 7.16 and Appendix 7.4.

The predicted operational noise levels were compared against the noise limits derived using the envelope based on the lowest average baseline noise levels as outlined in Section 7.4.2. The approach taken is a conservative approach to this aspect of the assessment. The results of the impact assessment are presented in Table 7.16. The operational predicted noise levels are compliant with the daytime and night-time noise limits at all locations.

Table 7-16: Assessment of Predicted L_{A90} Noise Levels for The Proposed Wind Farm Operation against Daytime and Night time Noise Limits

Receptor ID	Period	3	4	5	6	7	8	9	10
N1/107	Predicted Level	26.7	28.7	34.3	38	38.3	38.2	38.2	38.2
	Daytime limit	40	40	45.0	45.0	45.0	45.0	45.0	46.7
	Daytime Excess	-	-	-	-	-	-	-	-
	Night time limit	43.0	43.0	43.0	43.0	43.0	43.0	43.0	45.7
	Night time excess	-	-	-	-	-	-	-	-
N2/R106	Predicted Level	30.1	32.1	37.7	41.4	41.7	41.6	41.6	41.6
	Daytime limit	40.0	40.0	45.0	45.0	45.0	45.0	45.0	46.6
	Daytime Excess	-	-	-	-	-	-	-	-
	Night time limit	43.0	43.0	43.0	43.0	43.0	43.0	43.0	46.0
	Night time excess	-	-	-	-	-	-	-	
N3/R105	Predicted Level	27.4	29.4	35	38.7	39	38.9	38.9	38.9
	Daytime limit	40	40	45.0	45.0	45.0	45.0	46.1	48.8

Receptor ID	Period	3	4	5	6	7	8	9	10
	Daytime Excess	-	-	-	-	-	-	-	-
	Night time limit	43.0	43.0	43.0	43.0	43.0	43.0	43.0	47.1
	Night time excess	-	-	-	-	-	-	-	-
N4/R87	Predicted Level	28	30	35.6	39.3	39.6	39.5	39.5	39.5
	Daytime limit	40	40	45.0	45.0	45.0	45.0	45.0	45.0
	Daytime Excess	-	-	-	-	-	-	-	-
	Night time limit	43	43	43	43	43	43	43	43.8
	Night time excess	-	-	-	-	-	-	-	-
N5/R30	Predicted Level	23.4	25.4	31	34.7	35	34.9	34.9	34.9
	Daytime limit	40	40	45.0	45.0	45.0	45.0	45.0	45.0
	Daytime Excess	-	-	-	-	-	-	-	-
	Night time limit	43	43	43	43	43	43	43	43.8
	Night time excess	-	-	-	-	-	-	-	-
N6/R65	Predicted Level	27.8	29.8	35.4	39.1	39.4	39.3	39.3	39.3
	Daytime limit	40		45.0	45.0	45.0	45.0	45.6	48.1
	Daytime Excess	-	-	-	-	-	-	-	-
	Night time limit	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night time excess	-	-	-	-	-	-	-	-
N7/R58	Predicted Level	28.8	30.8	36.4	40.1	40.4	40.3	40.3	40.3
	Daytime limit	40	40	45.0	45.0	45.0	45.0	45.0	45.9
	Daytime Excess	-	-	-	-	-	-	-	-
	Night time limit	43	43	43	43	43	43	43	43
	Night time excess	-	-	-	-	-	-	-	-

It was demonstrated in Table 7.16 that the operational predicted noise levels for standardised 10 m height wind speeds from 3 m/s to 10 m/s are compliant with the daytime and night-time noise limits at all occupied dwellings and planning applications for noise sensitive location in the vicinity of the proposed wind farm.

7.5.2.2 Potential Operational Substation Direct Impact

In addition noise from the proposed substation has been assessed in line with BS4142, which has been outlined in section 7.2.2.4. This standard is based on a comparison of the background noise with the specific noise from the source to be introduced to assess the likelihood of complaints, as detailed in Section 7.2.2.4.

The background noise at the nearest locations to the proposed substation has been determined from the long term noise monitoring at location N6 (see Figure 7.2), which is east of the proposed transformer location. This is considered representative, as it is approximately 300m from the nearest noise sensitive location. Noise monitoring location N5 is also close to the substation location, but the prevailing noise is marginally higher and therefore N6 has been used, as a conservative approach to the noise assessment.

The daytime and night time background noise measurements ($L_{A90,\ 10min}$) have been filtered to exclude data for windspeeds above 5m/s and any data during which rainfall occurred. BS4142 categorises daytime as 0700-2300, with night time between 2300-0700. Note that measurements presented are for 10 minute intervals whereas normally BS4142 requires the background period is 1 hour during the day or 15 minutes at night.

Predictions have been carried out based on an example transformer; the Siemens TLPN7747 40000 / 50000 kVA. The sound power level for the transformer is 93 dB(A). The octave band profile for the transformer has been sourced from 'An Introduction to Sound Level Data for Mechanical and Electrical Equipment' published by CED Engineering. The A-weighted octave band data is presented in Table 7.17. If an alternative transformer is selected this will not exceed a sound power level of 93 dB(A):

Table 7-17: Octave Band Sound Power Level Data

Equipment	A-weighted Octave Band Centre Frequency (Hz)									Overall
	31.5	63	125	250	500	1k	2k	4k	8k	L_{WA}
Transformer Ω	81.0	87.0	89.0	84.0	84.0	78.0	73.0	68.0	61.0	93.0
Ω - Manufacturer's datasheet provided information on overall sound power levels. Octave band data was sourced from 'An Introduction to Sound Level Data for Mechanical and Electrical Equipment' CED Engineering										

Noise predictions have been carried out using International Standard ISO 9613, *Acoustics – Attenuation of Sound during Propagation Outdoors*. A worst case with plant producing their highest noise emissions has been assumed. The on-site substation transformer noise has been predicted in terms of the L_{Aeq}.

Table 7-18 summarises the basis of the BS4142 assessment of the transformer noise.

Table 7-18: BS4142 Assessment of Transformer Noise

Results	Daytime	Night time
Measured ambient plus predicted noise from transformer	(Residual 40 dB + specific 28 dB=) 40 $L_{Aeq, 60mins}$	(Residual 40 dB + specific 28 dB=) 40 $L_{Aeq, 60mins}$
Residual sound level	40 dB $L_{Aeq, 60min}$	40 dB $L_{Aeq, 60min}$
Background sound level (when source not in operation)	32 dB $L_{A90 (60mins)}$	28 dB $L_{A90 (15 mins)}$
Reference period	1 hour	15 minutes
Specific sound level	28 dB $L_{Aeq, 60mins}$	28 dB $L_{Aeq, 15mins}$
Acoustic character correction (none applied)	-	-
Rating level (no correction applied)	28 dB $L_{A90, 60mins}$	28 dB $L_{A90, 15mins}$
Background sound level	32 dB $L_{A90, 10mins}$	28 dB $L_{A90, 10mins}$
Excess of rating over background	-4 dB	+0 dB
Results	The difference is -4 dB. Where the rating level does not exceed the background sound level, this is an indication of the specific sound source having a low impact, depending on the context.	The difference is 0 dB. Where the rating level does not exceed the background sound level, this is an indication of the specific sound source having a low impact, depending on the context.

Results	Daytime	Night time
Uncertainty of assessment	As the difference is -4dB criteria, so the uncertainty of the measurement is unlikely to influence the outcome of the assessment.	As the difference is well below the criteria indicating a significant adverse impact (that is, rating level 5 dB above background), depending on the context, the uncertainty is unlikely to influence the outcome of this assessment.

Daytime Assessment

From the table above, there is a low impact predicted during the daytime. The effect of uncertainty on the outcome of the assessment has been considered. There is some uncertainty or variability in the noise level assumed for the transformer compared with that which will ultimately be installed. As measurements were conducted over 10 minute intervals, as opposed to the reference interval of 1 hour the background may also change slightly. The measurement period was for a long time and measurements which could be influenced by wind or rain have been removed which would minimise the uncertainty. These uncertainties are unlikely to change the result of the assessment and therefore there is a low impact as a result of the proposed substation during the daytime.

Night time Assessment

During the night time the difference in noise level between the rating level compared to the background indicates a low impact during the night time. As for the daytime, there is some uncertainty or variability in the noise level assumed for the transformer compared with that which will ultimately be installed. As measurements were conducted over 10 minute intervals, as opposed to the reference interval of 15 minutes the background may also change slightly. The measurement period was for a long time and measurements which could be influenced by wind or rain have been removed which would minimise the uncertainty. Even taking the uncertainty into account there is a low impact during the night time as a result of the proposed substation.

7.5.2.3 Potential Cumulative Impact

Windfarms within 20km of the proposed site and are shown in Figure 3.2 of Chapter 3. The IOA GPG defines the study area as including consented and constructed windfarms next to a proposed development. As detailed in the Description chapter, nearby consented and constructed windfarms within 20km of the development include:

- Cushaling Windfarm (9 turbines) at approximately 11km,
- Cloncreen Windfarm (21 turbines) at approximately 15km,
- Yellowriver windfarm (29 turbines) at approximately 17.4km
- Ballivor Wind Farm (26 turbines) at approximately 18 km has received planning consent.

Just outside the 20km limit are Owenstown Windfarm (3 turbine windfarm) approximately 20km from the site and Mountlucas Windfarm (28 turbines) approximately 23km from the Proposed Development.

The IOA GPG states (and as described in Section 7.3.2), cumulative noise impacts from any other constructed or consented windfarms in the locality need to be considered if the proposed windfarm produces noise levels within 10 dB of any existing wind farms. Noise produced from the adjacent windfarms are not within 10dB of the proposed windfarm and therefore cumulative noise does not need to be addressed.

The proposed development is next to Timahoe North Solar Farm, to the south east of the proposed development.

Based on the EIAR for this development the highest noise level predicted at the nearest noise sensitive locations to the site are presented in Table 7-19. A 2 dB addition to the predicted $_{LA90}$ from Drehid Windfarm has been added to convert the predicted level to an L_{Aeq} value.

The predicted noise levels meet the BS4142 noise criteria and therefore no further mitigation is required.

Table 7-19: Cumulative noise from adjacent Timahoe North Solar Farm

Location	Timahoe Substation Only (Night time operation)	Timahoe Substation and Inverter noise	Drehid WF Substation LAeq	Drehid Windfarm (10m/s) LAeq	Total Drehid Plus substation (Night time)	Noise Limit
Daytime H013 (R86)	21	-	21	38.5	38.7	0 dB above background noise At 10m/s (39 dB from Table 7.3)
Night time H013 (R86)	-	24	21	38.5	38.6	<40 dB

7.5.3 Potential Impacts during Decommissioning

Upon decommissioning of the proposed wind farm, the wind turbines would be disassembled in reverse order to how they were erected. All above ground turbine components would be separated and removed off-site for recycling. Turbine foundations would remain in place underground and would be covered with earth and reseeded as appropriate. These activities would be undertaken during daytime hours, and noise, which would be of a lesser impact than for construction, will be controlled through the relevant guidance and standards in place at the time of decommissioning.

Site access tracks could be in use for purposes other than the operation of the wind farm by the time the decommissioning of the project is to be considered, and therefore it may be more appropriate to leave the site access tracks in situ for future use. If the roads were not required in the future for any other useful purpose, they could be removed where required. This would involve removing hard core material and placement of topsoil. The impact is expected to be less than that during the construction stage.

It is proposed that the underground cable will be cut back and it will remain in-situ. The works associated with the cutting back of the underground cable will have a negligible impact.

7.5.4 Vibration Construction Phase

The potential for vibration at neighbouring sensitive locations during construction is typically limited to piling works, excavation works, rock-breaking operations and lorry movements on uneven road surfaces. The more significant of these is the vibration from piling and rock-breaking operations; the method of which will be selected and controlled to ensure there is no likelihood of structural or even cosmetic damage to existing neighbouring dwellings. The piling and rock-breaking activities will occur at least 600 m from noise sensitive locations. Considering the distances proposed from the majority of works and the nearest sensitive locations, vibration from construction activities will not have a significant impact.

7.5.5 Summary of Potential Impacts

With mitigation measures, the construction and decommissioning noise levels is predicted to be below the relevant noise limit of 65 dB LAeq,1hr for operations exceeding one month, and therefore construction noise impacts are not considered to be significant. However, there is potential for temporary elevated noise levels due to the instatement of sections of the internal access road and grid connection works. However, grid connection works will be for a short duration (i.e. less than 3 days) and where the works are required over an extended period, a temporary barrier or screen will be used to reduce noise levels below the noise limit where required.

Operational noise from the proposed turbines is predicted to meet the derived daytime and night-time noise limit at all occupied dwellings and planning applications for dwellings surrounding the wind farm and no mitigation will be required.

Operational noise associated with the introduction of the proposed substation is not considered to be significant.

7.6 Mitigation Measures

7.6.1 Mitigation Measures during Construction

The noise impact for construction works traffic will be mitigated by generally restricting movements along access routes to the standard working hours and exclude Sundays, unless specifically agreed otherwise. For example, during turbine erection, an extension to the working day may be required, i.e. 05:00 to 21:00, but this would be necessary only on a relatively small number of occasions. Where turbine deliveries are required at night it will be ensured that vehicles on local roads do not wait outside residential properties with their engines idling, and that the local residents will be informed of any activities likely to occur outside of normal working hours.

Consultation with the local community is important in minimising the likelihood of complaints and therefore construction will be undertaken in consultation with the local authority as well as the residents being informed of construction activities through the Community Liaison Officer.

The construction works on site would be carried out in accordance with the guidance set out in BS 5228:2009+A1:2014, and the noise control measures set out in the Construction Environmental Management Plan (CEMP). Proper maintenance of plant will be employed to minimise the noise produced by any site operations. All vehicles and mechanical plant will be fitted with effective exhaust silencers and maintained in good working order for the duration of the project. Machinery that is used intermittently will be shut down or throttled back to a minimum during periods when not in use.

The hours of construction activity will be limited to avoid unsociable hours where possible. Construction operations shall generally be restricted to between 07:00 hours and 19:00 hours Monday to Saturday. However, to ensure that optimal use is made of fair weather windows, or at critical periods within the programme, it could occasionally be necessary to work outside these hours. Any such out of hours working would be agreed in advance with the local planning authority.

As discussed in section 7.5.1 during the construction of the road for the turbine delivery route to the north of the site, there is potential for the noise limit to be exceeded at properties near the northern site entrance. Noise mitigation at this property could be provided by a combination phasing works and installation of a noise barrier between the turbine delivery route and the properties which are east and west of the access track. The noise barrier should just block the line of sight between the source and the receiver (highest window overlooking the construction works.

There is also a potential for the daytime noise limits to be exceeded during construction of the access track close to a family member of an involved landowner (R134), located east of the main southern site entrance. In addition, at this location, when the southern site entrance is used by HGV movements during all construction activities, there is potential for the daytime noise limit to be exceeded marginally (by up to 2dB). Note as a mitigation measure, access track layout has been moved eastwards to mitigate the construction noise impact at a property west of the site entrance. During the access track construction, the noise limits have the potential to be exceeded by up to 10 dB at location R134. Mitigation would be required both in terms of phasing works when close to the property and installing a noise barrier. A barrier will be installed on each side of the site entrance, and should extend from the site entrance northeastwards for approximately 80m, next to the proposed access track, in order to screen R134 and the property to the west of the site entrance. The height of the barrier should be 2.5m.

Barriers should have a minimum mass per unit surface area of greater than 7kg/m^2, with no gaps at the joints.

The predicted noise levels at other noise sensitive properties in this area are predicted to be below the construction noise limit.

With mitigation measures, the construction and decommissioning noise levels are predicted to be below the relevant noise limit of 65 dB LAeq,1hr for operations exceeding one month, and therefore construction noise impacts are not considered to be significant. However, there is potential for temporary elevated noise levels due to the grid connection works. However, these works will be for a short duration (i.e. less than 3 days) and where the works are required over an extended period, a temporary barrier or screen will be used to reduce noise levels below the noise limit where required. The noise impact will also be minimised by limiting the number of plant items operating simultaneously where reasonably practicable.

7.6.2 Mitigation Measures during Wind Farm Operation

The results of the noise predictions presented in Section 7.5.2 and Appendices 7.4 show that operational noise levels meet the derived daytime and night-time noise limits at all residential properties (including mobile homes and planning applications) surrounding the wind farm. Therefore, no mitigation is required for windfarm operational noise. (Appendix 7.3 provides full details on octave band spectra for standardized 10m wind speeds ranging from 3 m/s to cut out).

7.6.3 Mitigation during Decommissioning

The noise impact for construction works traffic would be mitigated by generally restricting movements along access routes to the standard working hours and exclude working on Sundays, unless specifically agreed otherwise with the local authority. In addition any noise barrier mitigation identified during the construction phase would need to be considered, if noise sensitive locations are similar distances from the decommissioning works.

The decommissioning works, which will be at a lower impact than construction works, will be carried out in accordance with the policies and guidance required at the time of the works, and restricted to normal working hours, typically 07:00-19:00 hours Monday to Saturday.

7.7 Residual Impacts

With mitigation measures, construction activities with a duration longer than one month are predicted to be below the construction noise limit of 65 dB $_{LAeq,1hr}$ at residential properties. As a result, residual construction impacts are not considered to be significant when assessed under these criteria.

There is potential for temporary elevated noise levels due to the instatement of sections of the access track and grid connection works. However, these works will be for a short duration at a particular property (i.e. less than 3 days) and where the works are to occur over an extended period, a temporary barrier or screen will be used to reduce noise level below the noise limit.

Operational wind farm noise levels meet the derived night and daytime noise limits at all residential properties surrounding the wind farm which, under this criteria, is not considered to be of a significant impact.

The transformer selected for this site will be selected to ensure that it does not operate above the 'achievable' reference sound pressure level and the noise emissions from the proposed substation will be below a rating level of 35 dB $L_{Ar,Tr}$ which are considered to be very low and there will be no residual impacts.

7.8 References

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